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SEWAGE EXHALATIONS

THE

CAUSE OF DYSENTERY.

AN ACCOUNT OF AN OUTBREAK OF DYSENTERY IN
THE CUMBERLAND AND WESTMORLAND ASYLUM,
WHICH WAS CAUSED BY THE EFFLUVIA FROM A
FIELD IRRIGATED BY SEWAGE.

BY T. S. CLOUSTON, M.D.,
MEDICAL SUPERINTENDENT.

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The Cumberland and Westmorland Asylum is built on a dry, sandy hill, about three miles from Carlisle. There are no manufactories or polluted streams near it. The subsoil of the land lying at the base of the hill on which it is built is a stiff brick clay. The water supply is derived from a small stream which arises from the drainage of neighbouring fields, and from several springs in those fields. The water was analysed before the site was determined on, and found to be very pure. The building is well ventilated, and the water-closets and drains were constructed on the most approved principles. Two of the soil drains, however, have frequently had to be taken up since the opening of the institution on account of being choked up when rags, etc., were thrown down the water-closets by the patients. The water from the baths and lavatories is not thrown into the sewage drains, it having been thought that the sewage would be too much diluted if mixed with it. The main drain conveys the sewage to a large vaulted close tank, 40 feet by 40 feet, and 6 feet 6 inches in height, situated about 150 yards from the nearest inhabited part of the Asylum—a small detached block—and 200 yards from the main building. It was intended that the sewage should be pumped out of this tank into carts, and so distributed over the land. The solid part was to be allowed to accumulate in the bottom of the tank, and to be cleared out through a man-hole at the top at periodic intervals.

The Asylum was opened in the beginning of 1862, and has since generally contained over 200 patients. Many of those, as in all Asylums, are paralytics, weak epileptics, and maniacal patients, whose nervous energy has been greatly exhausted by previous excitement. Many of the patients are old and weak when sent from workhouses to the Asylum. There are about thirty sane people connected with it as officials, attendants, and workmen. The regular diet of each male patient consists of 24 ounces of cooked animal food, 14 pints of milk, 16 ounces suet dumpling, 7 pints of oatmeal porridge, 78 ounces of bread, 7 pints of tea, and $3\frac{1}{2}$ ounces of butter per week. The females have somewhat less solid food, and coffee as well as tea every day. Extra diet of all kinds is given to the sick and weak. Stimulants are only given by Medical order, not even beer being a part of the regular dietary of the patients or

their attendants. Each patient has from 500 to 900 cubic feet of air in the dormitories and single bedrooms, and more than this amount in their dayrooms.

During the first two years after its opening, the mortality in the Asylum was not half the average mortality in all the other county Asylums. No epidemic appeared in the Asylum till the end of 1863, when there were two cases of typhoid fever, one of which proved fatal. A source of contamination of the water supply was at that time discovered and remedied. It consisted of the contents of a drain which received the slops of half a dozen cottages and the washings of a few hundred yards of a public road. No water-closets emptied themselves into this drain. The cases of fever were of the ordinary type in all respects, and the post-mortem appearances in the one that died were such as are ordinarily found in such cases. I attributed them at the time to the impure water. During the first two years after the opening of the Asylum, diarrhoea was not unusually common among the patients, not more than a dozen cases having been treated for it each year.

Towards the end of February, 1864, a patient who suffered from chronic pleurisy, and whose mental state was that of the most extreme dementia, was attacked by severe and prolonged diarrhoea, with some dysenteric symptoms. The dysenteric symptoms passed off, but the diarrhoea continued till he died, in June. This case attracted no unusual attention, until, in the beginning of April, three men were attacked with very severe dysentery within five days of each other. One of them was a general paralytic, in the last stage of the disease; the second had paralysis agitans in a severe form, and they both died within a week; the third was aged 81, and laboured under chronic mania, and he died in three weeks.

I shall describe the dysentery more particularly afterwards, however. It presented sufficiently marked and novel features to warrant a very full description of its pathology. In the meantime I shall confine myself to the history and etiology of the epidemic as an epidemic.

On May 8, two men were attacked by the disease, one of them an attendant, a young man in robust health, who had only been three days in the Asylum, and both ultimately died. No cases then occurred until June 3, when a woman was attacked by the disease, and, as she was previously phthisical, she very soon died. In the same month four other female patients were attacked, two of whom died. One of those who died was a deaf and dumb epileptic, of feeble nervous power; the other, an old woman of 65. Of the two who recovered, one was a woman who had been for a long time subject to severe dyspeptic attacks, accompanied by a tendency to diarrhoea, and the other was a previously healthy congenital imbecile. On July 2, a man was attacked and died. On July 6, two women were attacked by the disease, one of whom,

aged 66, previously exhausted by chronic mania, died, and the other, a congenital imbecile, recovered. On the 13th, a man and a woman were attacked by the disease, both of whom died. They were aged 73 and 66 respectively, and the man was partially paralysed. Between the 17th and the 22nd four men were attacked, none of whom died; but one of them was attacked again on August 2 and died. The disease was apparently checked at first by astringents and opiates in this case. On August 2, and on the 4th, two cases were attacked and both recovered. On the 7th a woman was attacked and died. This woman had been previously in good bodily health. From the 18th to the 23rd of August three cases were attacked, one woman and two men. The woman (a general paralytic) died; the two men, one of whom laboured under phthisis, recovered. These were the last cases that occurred in 1864.

Of the twenty-six persons attacked nineteen had been inmates of the wards on the ground floor of the Asylum. Eleven of them had slept in bedrooms on the ground floor. All the women attacked had been inmates of this ward, except one who lived in the detached block near the sewage tank. I may mention, however, that in the wards on the ground floor, the majority of the weaker, older, and paralysed patients reside, in order that they may have freer access to the airing courts.

On March 12, 1865, a woman was attacked by diarrhoea, which gradually passed into dysentery, with slight bloody and purulent evacuations; and on the 19th and 28th, within forty-eight hours four women were attacked with dysentery. All those five cases were in the ward on the ground floor. The four who were last attacked all died, although two of them had been previously in average health.

Altogether, therefore, thirty-one persons were attacked by dysentery, of whom twenty died.

During all this long-continued prevalence of the disease in the Asylum, I find from my prescription-book that diarrhoea was much more common than in the two previous years, but this is, no doubt, partly accounted for by the extreme vigilance of the attendants in watching for and reporting at once all cases that had the smallest symptom approaching a bowel complaint, and its immediate treatment by me. No doubt I treated many slight cases of diarrhoea that but for the prevalence of the epidemic I should never have heard of. But making ample allowance for these, ordinary diarrhoea was much more prevalent than usual. There were no cases of very severe and continued diarrhoea, however, that would not yield to treatment by astringents and opiates. We shall see, when we come to describe the dysentery more particularly, that it seldom was preceded by long-continued diarrhoea, but in by far the majority of the cases appeared as dysentery almost from the beginning.

Cases of erysipelas were not more common than usual, and there was no other epidemic disease prevalent in the Asylum.

From the time when the first case of dysentery occurred, I endeavoured to discover the cause of the disease, well knowing that there must be a cause either in the unfavourable hygienic condition of the Asylum or in the food or water. The drainage was the first thing looked to. That, with the exception of the one drain that was frequently being obstructed to which I referred, was found apparently in a satisfactory condition. And the period when the patients were attacked with dysentery I found to bear no relation to the periods when the drain was obstructed and the ground, opened to clear it out. The whole Asylum was thoroughly and specially cleaned, and the water-closets kept sweet. McDougall's disinfecting powder was used largely whenever it could be applied. The bread, water, and milk were analysed by Dr. Macadam, of Edinburgh, and found to be free from any obviously deleterious matter. The water was made to pass through a charcoal filter, and boiled before being used for drinking by the patients. All the feeble patients were sent up to the upper wards; they were all made to wear flannel shirts and drawers, and the ventilation was increased by opening the upper sashes of the windows during the night. All those prophylactic means proved unavailing. Still fresh cases occurred, and I confess that I was almost hopeless as to discovering the cause of the epidemic. The soup which the patients had as part of their dietary was discontinued. All the patients in the lower wards had twenty minims of diluted sulphuric acid administered to them three times a-day, because during the cholera epidemic it had been recommended as a prophylactic for bowel complaints generally, but one or two of them were attacked while taking the medicine. The dietary did not seem to be at fault, for many of the weakly patients had been on quite a different diet from the ordinary patients, and yet took the disease. The want of stimulants did not seem to be the cause, for many of those same patients had been getting stimulants of all kinds in considerable quantity.

Although in the asylum there had been no other epidemic disease while the dysentery prevailed, yet in March and April three of the inmates of a cottage a few yards from the asylum had typhoid fever. The first of the three attacked had not been staying at home except on the Saturday and Sunday nights previously, and he was never brought home, but taken to the next village. A month after he was attacked the two inmates of the cottage who had always been living there took the disease. They had frequently been to see their brother while he was ill, and at the time I resolved that for the future I should always adopt the same precautions in the case of typhoid fever as in diseases usually supposed to be infectious.

It had often occurred to me whether the dysentery might not

be connected with the distribution of the sewage of the Asylum. I mentioned that this was thrown into a large tank, and that it had been intended to pump it up into carts to be distributed over the land. But this was found to be impracticable from the large quantity of sewage. An opening was therefore made in the upper part of the tank, and the liquid part of the sewage which overflowed at this opening was conducted by open cuts to irrigate about three acres of grass land immediately below it. The opening through which the sewage escaped from the tank was only about six inches square. The irrigated field was about 300 yards from the female ward in which the greater number of cases occurred, and 350 yards from the corresponding male ward. The land had been drained shortly before the Asylum was opened. The upper part of it had a sandy subsoil, and the lower and greater part of it had stiff brick clay under the soil. The direction of the cuts was often changed to make the sewage run on different parts of the field, but this was not done very scientifically.

The reasons which at first made me think the application of the sewage had nothing to do with the dysentery were these:— 1st. The sewage had been so applied for two years previously, during which there had been no epidemic diseases of any kind. 2nd. Sewage had been applied in much the same way in many other places, and I had not heard of any epidemic diseases being produced. Jock's Lodge Cavalry Barracks are situated by the side of an immense extent of land which is always being flooded by all the sewage of Edinburgh, and they are said to be the most healthy barracks in the kingdom. How could the sewage from a building with 250 people do any harm, therefore? And at many Asylums I know the sewage to be used in the same way quite close to the building. 3rd. I had never heard of dysentery being connected in this country with sewage exhalations as a cause at all. 4th. I had never perceived any offensive smell at the house; and 5th. Although a very offensive odour was perceived near the irrigated field, yet I was inclined to hold the views of Professors Christison and Bennett, of Edinburgh, as to the general harmlessness of stinks.

In the month of August, however, an offensive odour from the sewage was clearly perceived at the Asylum during several hot sultry evenings, and I considered it advisable to convey the sewage away from the tank in a covered drain to the boundary of the Asylum farm, where it is thrown into a deep ditch and largely diluted with water. After that time no more cases of dysentery occurred in the Asylum during the year 1864, and those at the time labouring under the disease recovered.

The sudden termination of the epidemic coincidently with the removal of the sewage exhalations at a time of the year when dysentery is beginning to be most prevalent, afforded a very strong presumption that the effluvia and the epidemic of dysentery were

cause and effect. The fact that the tank had not been thoroughly cleaned out for two years, and that the land was a stiff clay through which the sewage would not readily percolate, was strongly confirmatory in my mind of this view. But in order to apply what I considered to be a sure test, I made out a list of the days on which the patients were attacked by this disease, and sent them to a meteorologist well known in the neighbourhood for the accuracy of his observations—the Rev. F. Redford—asking him to tell me the direction in which the wind was blowing on those days. The irrigated field was to the north of the Asylum, and I expected to find that the wind had been blowing from that direction each day. I then thought that such a poison must be in operation up to the time when the disease begins. But the list was returned to me with only one day marked with a north wind. I then asked him to give me the number of times the wind had blown from the north during the fortnight previous to the outbreak of the disease. It had been from that direction in fifteen out of the twenty-two periods of attacks, and in all the cases it had blown for more than one day from that direction. But the seven remaining periods, which were all in July and August, when there had been no north wind, still puzzled me, until I remembered that it was during a sultry evening with no wind that the sewage smell had been perceived at the Asylum. On a more careful examination of the meteorological record, I found that such evenings had preceded the outbreaks of the disease, not only in the seven cases unaccounted for, but also in many of the other cases when the wind had been blowing from the north during the day. A further examination showed that within a week of each outbreak of the disease there had been either north winds or hot sultry evenings, with no wind during the night. I also found that in the spring and early part of the summer when the outbreaks had occurred at one time on the male side of the house, and at another on the female side, and there were no calm evenings preceding, that the wind had blown from a point west of north before the male patients were attacked, and due north before the females were attacked. This was precisely what might have been expected, for the building stands east and west, and being a long building the wind would require to blow somewhat from the west to bring the effluvia to the male side. Indeed, it would seem that the number of cases attacked were in the ratio of the number of times the wind had blown from the north or the number of sultry evenings previously. Between April 5 and 14 three males were attacked, and the wind had blown from the north or north north-west at least twelve times from March 26 till April 14; and from the beginning of March up to the 9th, there had been several evenings quite calm, with a high barometrical pressure. This last condition I found to be very common during the fortnight preceding the attacks. It would obviously tend to prevent the diffusion of the effluvia through the atmosphere, thus keeping it

near the ground, and accounting for the great number of patients in the wards on the ground floor being attacked. Then on May 8 a male patient and the male attendant were attacked by the disease. I found that there had been four calm nights immediately preceding this date, and that the wind had blown twice from the north north west during the day. Again, on June 3, a woman was attacked, and another on the 9th. I find that the wind had several times blown from the north previous to those dates, and that there had been several warm, calm nights. Certainly no conditions could be more favourable for such a poison to produce its effects than when a warm night with a high barometrical pressure caused strong exhalations, while a gentle wind from the proper direction wafted them in through the windows I had caused to be opened to let in fresh air, to be breathed by my patients when they were asleep and most liable to their deleterious influence.

From the first of the season, up till July, when the direction of the effluvia would be determined chiefly by the wind, males and females were attacked at different times, according as the wind blew towards the male or female side of the Asylum; in July and August, when, through the sultry calm nights, with a high barometrical pressure, the effluvia would spread in all directions along the ground, males and females were attacked promiscuously.

Although I could no longer doubt that the sewage effluvia had caused the dysentery, yet I attributed this to the state of the sewage chiefly, and secondarily to the kind of soil to which it had been applied. As those who had houses further down along the stream into which the sewage was emptied objected to its being allowed to run there permanently, and as I believe, if it were properly applied, it would be harmless to the health of the inmates of the Asylum, I had the tank emptied and thoroughly cleansed. I was to have had the field better drained and levelled, and deeply trenched, so that the sewage might be spread over a larger surface, and applied more scientifically, and that the extra liquid might drain away. All this could not be done at once, and in the course of the operations the drain had to be taken up which conveyed the sewage from the tank. While this was up the sewage had to be accumulated in the tank when the wind was blowing from the north, and allowed to run off by a pipe from the bottom of it when the wind was blowing from other directions. But for one night this had been allowed to run on the land when, as I ascertained in the morning, the wind had been blowing towards the house. It had been nearly calm during the night, too, as I afterwards ascertained. In a week from that time those five cases of dysentery occurred. But another cause must have been in operation, for an obstructed drain was found near the ward in which the cases occurred, which had formed a little cesspool under the soil immediately below the windows of the ward. This can only have existed for a few days, until the soil was saturated and the water rose, as it did at last, into the water-

closets. The drain was, of course, at once repaired, the soil removed, McDougall's powder thrown in, and fresh soil was substituted.

This outbreak of dysentery was, therefore, in all points confirmatory of my previous conclusions as to the bad effects of sewage effluvia; but it showed that it was not necessary for that sewage to have been pent up in large quantity for a long time to become prejudicial to health. The sewage that was run over the land immediately before the dysentery broke out this time was fresh from the drains, the tank having been thoroughly cleansed out. The land to which it was applied had had no sewage applied to it for some time, but, in afterwards trenching this land, it was found that the sand from the upper part of the field had completely obstructed the drains through the clay, so that it had been, latterly, at least, as if it had never been drained.

Shortly before this time one of the men employed by the Asylum had involuntarily made himself the subject of an experiment showing the poisonous effects of sewage gases. He was putting a new tile in a drain, and happened to put his head close to its mouth, breathing a quantity of the foul air that emanated from it. For the next four days he felt languid, had no appetite, felt very cold at times, had a sensation of something in his throat which made him swallow, and often had the sensation of smelling the drain again. He then was seized with severe pain in the abdomen, as if his "inside were being twisted out." This was shortly followed by vomiting and severe diarrhœa. He says the matters vomited smelt of the drain, and the dejections were very foetid and of the same odour. He then had a pinched look, his tongue was coated with a thick, dirty, yellowish fur, his breath was offensive, his pulse was quick and feeble, and he could take no food. The diarrhœa continued and became worse, till he could scarcely leave the water-closet, and the evacuations were slimy and mucous, and were slightly tinged with blood, while he had a great straining at stool. During all this time the pain was very intense in the abdomen. He said he felt as if his inside were all going away. He had been taking Dover's powder from the time the diarrhœa became very severe, and he seemed to think that on the second day, when the blood appeared in his stools, the powders relieved the pain and lessened the diarrhœa; which continued in a less severe form, however, for two days longer, with no blood in the dejections. It then ceased, leaving the patient weak for another fortnight. The day after the diarrhœa ceased he had very great difficulty in micturition.

This man had not slept in the Asylum, but three miles away from it; he had been in every respect, a strong healthy man previously, and there had been no cases of severe diarrhœa or dysentery in the Asylum for four months previously. It therefore seems certain that the foul air he breathed from the drain was the

cause of his illness; and we shall see, when I describe more fully the dysentery which occurred among the patients, how much his symptoms resembled theirs. This is, therefore, a most instructive case.

As to the extent to which diarrhœa prevailed among the attendants, and servants, and officials in the Asylum during the period when dysentery was prevalent, I find that at least a dozen of them had it in a more or less severe form. In some cases it was coincident with the outbreaks of dysentery among the patients. Many of them had never had such attacks in their lives before. It seems reasonable to infer that the poisonous effluvia which in the case of the patients and the one attendant caused dysentery, was got rid of more easily in the other cases, and merely caused diarrhœa, just as it did in the workman's case who breathed a whiff or two of the undiluted air from the drain. Another curious fact, that may have reference to the action of the poison, is, that at the time when the last five patients were attacked by dysentery this year two other women in the same ward in which they resided (that on the ground floor), who had had dysentery last year and recovered, were observed to lose their appetite, to become listless, and to cease to occupy themselves. They were both imbeciles, and could not describe their sensations; but this state continued a fortnight, when they again resumed their usual condition. All this time they had been getting quinine and iron. They had no diarrhœa. Does not this point to the influence of the same poison on persons who had become somewhat inured to its influence, and on whom, therefore, it had lost its full effect?

As the sewage effluvia had evidently produced the dysentery, I began to think that it might have had something to do with the typhoid fever too. The first inmate of the cottage attacked was only at home on the Saturday nights and Sundays. On the Saturday and Sunday nights, March 19 and 20 (he had been attacked on the 22nd), the wind blew from the east and north chiefly, and the nights were calm. This direction of wind would not bring the effluvia to the cottage, and it is unlikely that the calm would be so complete at that time of the year that the effluvia would spread in all directions; but on the previous Saturday and Sunday nights the wind had blown from the N.W., veering to the W.S.W., which would be the precise direction to bring it to the cottage. He would breathe the effluvia for two nights, nine days before he had been attacked by typhoid fever. The other two inmates of the cottage were attacked on April 17, and up to April 9 from the 5th there had been calm nights with a high barometrical pressure, and the wind blowing from the N.N.W. They, too, had certainly been breathing the effluvia for four days and four nights eight days before they were attacked; and I also find that though there were no north winds in the fortnight preceding the time when the two patients were attacked with typhoid fever in the Asylum

on October 29 and December 1, 1863, yet in the fortnight preceding the former period there were seven perfectly calm nights, with very high barometrical pressure and five such nights in the fortnight before the latter date, which is certainly an unusual circumstance at that season.

I have endeavoured to find out the period of incubation of the poison, during which it was in the system before it produced the dysentery. If north winds and calm evenings had occurred singly, this might have been done accurately, but in most cases the effluvia was breathed for two or three days at a time, and taking the period of fourteen days before each case was attacked, I find that in that time the cause had been in operation more than once. That the poison produced the disease in three days from the time of its inhalation, I have positive evidence in the case of the attendant, who had only been in the house for that time, when he was seized with it. The sewage exhalations had been breathed by him during all that time. Then there were four days of incubation in the case of the workman who breathed the gas contained in the drain. One of the patients was attacked on June 18, and for three days before that the wind had been blowing briskly from the south west, so that in this case there must have been at least three days of incubation. Another case was attacked on June 13, and there had been no north winds, or periods of absolute calm for five days.

In regard to the five cases attacked this year, it was six days from the time when the sewage had been running over the land during the night, with a north wind blowing, until the cases were attacked, but during the four succeeding nights there had been an absolute calm, so that any effluvia still rising from the ground would be breathed by the patients. And then there was the obstructed drain, which was obstructed up to the time when the patients were attacked. It would seem that the sewage poison took from three to six days to produce the dysentery after it had been inhaled. It is quite impossible to say that in some cases it may not have produced it in less time. My experience does not determine that point.

In one case the action of the poison seemed to be hastened by a dose of castor oil, which had been given to overcome constipation; for the ordinary purgative effects of the medicine passed into a severe and fatal attack of dysentery.

My friend the meteorologist informs me that the occasions during which the wind blew from the north before the outbreaks of dysentery were almost the only occasions on which the wind had been from the north.

The Dysentery.—The type of dysentery which occurred here was so different in many respects from any of the accounts of dysentery with which I have met, that I think it demands a full description. In many of its symptoms, in the treatment

most successful for it, and in its pathology, it differed widely from tropical dysentery.

All the cases did not commence in precisely the same way. Some of the patients had ordinary diarrhœa from periods varying from two to three hours up to twenty-four hours before blood appeared in the stools. In some cases there was great pain in the abdomen for twenty-four hours before the diarrhœa set in; in other cases there was scarcely any pain at any period of the disease. In some cases there were febrile symptoms at the beginning; in others these were absent till the disease had advanced considerably.

There were two classes of cases. In the first, the patient had two or three loose stools, or perhaps had no ordinary stools at all, but at once began to pass glairy mucus mixed with blood, in small quantities at a time, from the bowel. He had no pain, no fever, no want of appetite, and he refused to believe he was ill. This would continue for a day or two, and then the blood would increase in quantity, and the stools become more frequent. Pain would begin to be felt in the region of the rectum, and the pulse would mount up ten or twelve beats. For days the patient would be at stool every hour or two, and of course would become weaker. His tongue was then seen to be coated with a dirty yellowish white fur, but the appetite for such forms of nourishment as milk, strong beef-tea, calves-foot jelly made with wine was good. Solid food was not relished. The stools would then be seen to be coated with a semi-fibrinous semi-purulent looking membrane. The tongue would then become clean and glazed and beef-steaky; the evacuations become fæculent, mixed with pus, the latter element becoming gradually less as the patient advanced in his slow convalescence.

In the second class of cases, the patient had from the first great pain in the abdomen of a griping kind, a hot skin, and a pulse over 100; the dejections were copious and frequent and watery, while they were largely mixed with blood. In many cases there was sickness; in all loss of appetite. After some days the tongue and mouth would become dry and parched and black; the features pinched; the pulse small and quick; and death soon ensued. In some cases the stools would, after a time, become membranous and shreddy, and then purulent, till the patient was more gradually weakened and exhausted. One such case lived six weeks, and the attendant lived two months. Of course, this greatly depended on the previous strength. In only one of the seventeen cases of this class did the patient recover.

All the cases had the following features in common: bloody stools at first, tending to become purulent, intense fœtor of the evacuations during the whole of the disease, no scybala, and great thirst. The laundress could not wash the soiled linen without vomiting, until it had been deodorised by chloride of zinc.

As regards the previous bodily health and condition of the cases attacked by the disease, it may be best judged of when I mention that, of the thirty-one cases, only eleven had been in really good health. All the patients first attacked were very weak or very old. The attendant was the only exception to this. The disease did not confine itself to patients labouring under any one form of mental disorder; but it is remarkable that, though there are only, on an average, about eight patients in the Asylum labouring under general paralysis, three of these should have died of dysentery, and out of about the same number of congenital imbeciles and idiots, four should have had the disease. It would seem, therefore, that the chief predisposing cause of the disease was diminished nervous energy rather than impaired nutritive power, for several of the patients, especially those congenital cases, were fat and well nourished.

The high rate of mortality must be looked upon as owing quite as much to the state of the patient attacked as to the fatal character of the disease. But then the attendant, who had been strong and vigorous in every respect, was carried off by it, although he was removed away from the Asylum, showing that its fatal effects were not owing to weakness or impaired nutrition entirely; and one old man of 65 recovered, showing that the disease might assume a very mild form indeed.

I have no evidence whatever that the disease was infectious. The outbreak of the disease at first, the outbreaks in wards the patients of which had had no communication with the wards in which the dysenteric patients had been, the long intervals when there were no cases in the house, and the fact that the attendant who took the disease did so after three days' residence, when there were no cases in the house, and the entire immunity of the nurses who specially attended the sick, changed their linen, bathed them, etc.—all those facts go to prove nearly conclusively that the disease was not infectious.

Treatment.—In treating the first cases of the disease I naturally used opiates and astringents. I found them to be of no service whatever in the first stages of the disease. The opiates decidedly did harm in any form given by the mouth, except Dover's powder, as they caused sickness. The astringents were useful in the latter stages of the disease, and I should be at a loss to say which of the numerous vegetable and mineral astringents I found most useful, for I found each of them useful, when first given, for a day or two, but they then lost their effect. During the stage when the evacuations were purulent and the blood in them disappearing, I found it of much service to give tannin, gallic acid, acetate of lead, sulphate of copper, sulphate of zinc, nitrate of silver, alum, logwood, and powdered cinchona in this way. Decoction of pomegranate root I found of no service. The famous ipecacuanha treatment, so universally practised, and so

implicitly relied on in the treatment of tropical dysentery, I tried in every possible way. So far as I could judge, the results were, that in a few cases it caused vomiting that could not be stopped, and prostration that was never rallied from; in a few cases it caused no sickness even when given in large doses, and then it diminished the quantity of blood in the evacuations, while, in the majority of cases, it caused temporary nausea, without doing any more harm or any good. I gave it in the very first stages of the disease, often both by the mouth and the rectum. I gave it in all doses, from a drachm down to ten grains. I gave it alone and in combination with opium, and after opium. I gave it once a day, and I repeated it every two hours in different cases, and the above is the unsatisfactory conclusion I must come to. Purgatives I found to aggravate the disease most unmistakably. Enemata of astringent substances I found useful in the latter stages of the disease in the cases that were going to recover, and a little opium with these increased their good effects. Enemata given by the long flexible tube, recommended by Mr. Hare, aggravated the symptoms, or rather the flexible tube in being passed up the inflamed and irritable rectum caused intense and unbearable pain. I tried iron in the form of the tincture muriate and of the solution of the perses-quioxide with as little good effect in the first stage of the disease as the other remedies. Creosote given by the mouth diminished the sickness in many cases, and also diminished the fœtor of the evacuations. Tincture of iodine was also ineffectual. Large doses of quinine were tried, but ineffectually. Chlorate of potash was also tried unsuccessfully. Diuretics were also tried in the cases where the urine was scanty and deposited urates, but they seemed of no service. Blisters over the abdomen were useless. The only plan of treatment that I was quite sure did the patients good was to remove them to the third story, to give them as much nourishment in a liquid form as they could possibly be got to take, and to give them wine and water *ad libitum*. Large vessels of milk, boiled with a little flour, and allowed to cool, were always kept by the patients day and night, and the nurses were ordered to give them some of this as often as they could be got to take it. Small pieces of ice were always grateful to them, and when there was nausea or vomiting helped to allay it. Strong beef-tea was given *ad libitum* to those who could be got to take it. Calves'-foot jelly made with wine was given to those who would take it. Soft boiled eggs in some cases were taken and did not increase the purging or cause pain after they were taken. But of all the forms of nourishment the boiled milk was taken most readily by the greater number of patients, and kept up the strength best. This was Sydenham's most trusted form of nourishment in the dysentery of his day, and certainly I found it by far the best. Patients would take it when they would take

nothing else, and it never caused griping or an increase of the dejections, as any kind of solid food was so apt to do. During convalescence I did not find solid animal food in the least objectionable.

In three of the cases the patients got out of bed too soon, and had relapses of the dysentery, and then astringents were decidedly beneficial. They seemed to subdue the symptoms at once.

The cases varied extremely in the time they took to recover completely. One man recovered in a week, another was two months ill. The average duration of the disease was about five weeks. This includes the time during which the preceding and succeeding diarrhoea lasted. None of the patients who recovered had bloody stools more than a month.

Of the patients who died one lived four months, but in his case the cause of death was a sequela of the disease, and the ulceration of the gut was found cicatrising after death. Another case (the attendant) lived two months from the commencement of the disease. Several of them lived a month. A week was about the average length of time, and one case died in two days. All the patients who died in the short periods had been in weak health, or laboured under some other disease previously.

If I had now a case of the first type to treat, I should give Dover's powder in ten-grain doses three times a-day, and a large enema every morning containing a drachm of ipecacuanha and two drachms of compound kino powder, till the blood in the evacuations became very small in quantity, and pus had made its appearance. I should then give astringents in the ordinary medicinal doses, continuing each for two days only, till the patient was well. If I had a case of the second type of the disease, I should give ipecacuanha in small doses tentatively; and if it caused sickness, I should try quinine and astringents, to satisfy my conscience; I should give all the liquid nourishment and stimulants I could get the patient to take, believing that if he had any chance of recovery they would enable him to have it; but I should give the patient up as incurable from the first.

Pathology.—The morbid appearances found after death are the most distinctive and interesting features of the disease. Of the twenty cases who died, I performed post-mortem examinations in sixteen. Some of the cases were in the very first stage, while the others were in all the intermediate stages, and in one case I saw the state of the intestine after it had healed; but perhaps I had better describe a typical case first, and afterwards mention the varieties. In such a case all the abdominal organs would be found healthy until the small intestine was examined. This, too, would be normal up to within five or six feet of the cæcum. The mucous membrane would then begin to appear reddened in small spots or rings round the gut. Six inches further down, the redness would

be universal, and the membrane would begin to be thickened and corrugated into folds like small *valvulae conniventes*. A few inches further down, a yellowish, dirty-looking deposit would be seen over the mucous membrane in rings, very thin where it began, but gradually becoming thicker and more continuous till near the cæcum, it would be one-eighth of an inch in thickness. The swelling of the mucous membrane would also increase downwards, and the artificial folds running across the gut become more prominent. These, with their coating of deposit, made the inside of the bowel look like a series of thick transverse ridges covering its entire surface. This deposit when examined would be found to be soft on the surface, but getting more firm towards the mucous membrane, with which it incorporated itself, so that it could not be scraped off without leaving the fibrous covering of the muscular coat exposed, as a highly vascular, raw-looking surface. This deposit though on the surface a soft lymph-looking substance, yet towards the mucous membrane it assumed quite the consistency and appearance of a soft fibrous membrane. The cæcum when examined in such a case would be found in the same state as the lower part of the small intestines, with two or three ragged ulcerations the size of beans; in the ascending colon the ulcerations became deeper and larger, while the lymph deposit on the surface of the mucous membrane became thicker and more fœculent in colour. Towards the transverse colon the inside of the gut was one mass of large irregular ulcers, with patches of the deposit between them. The colour of the whole surface was almost black, and this continued down to the very lower part of the rectum.

The mesenteric glands opposite the affected parts of the small and large intestine were enlarged and dark coloured, and on section were soft, and pulpy in consistency.

Such were the external appearances in a case that had lasted for about a month. On examination of the fibrinous layer by the microscope, in the fresh state, it was found to consist of nucleated cells like pus cells, fusiform cells with nucleus, and a fibrinous material between. When a small portion of the gut was hardened in absolute alcohol or dilute chromic acid, and thin sections made of the gut transversely, showing all the coats, the peritoneal coat was seen to be normal, the muscular coat also normal, except that part of it in proximity to the mucous membrane, which was more than usually vascular. In the fibrous and mucous coat the blood-vessels were enlarged and very tortuous, and on the free surface of the mucous membrane between the villi they could be seen torn and open-mouthed. The villi were enlarged, stripped of their epithelium, and lying in contact with them and dipping in between them were the fusiform and round nucleated cells. The fusiform cells predominated near the villi. Minute fibres radiated from the villi through the layer of lymph substance, branching

out and losing themselves at the free surface. Those fibres seemed to bind together the cells, and when a section through the deposit was made on the same plane as the surface of the mucous membrane, an areolar appearance was seen, the meshes being filled up with cells.

One woman died after two days' illness, and after death the solitary glands in the last part of the small intestine were found enlarged. Peyer's patches were quite unaffected; in the cæcum the mucous membrane was reddened and thickened in small patches running into each other, like the eruption on the skin in measles. In the transverse colon the whole mucous membrane was mottled and thickened. In the descending colon and rectum the mucous membrane was less diseased. In the rectum the mottling was mixed with small red points like pins' heads. There was no trace of ulceration anywhere. In this case there had been copious bloody evacuations. The torn capillaries, even where there was no actual ulceration, would of course account for the bleeding. There was no membranous deposit.

In a case which had died in five days from the commencement of the disease the mucous membrane of the small intestine was for six feet above the cæum reddened, thickened, and thrown up like *valvulæ conniventes*, with a little deposit on them. The mucous membrane of the large intestine was completely covered with a thick layer of the yellowish lymph matter described.

In another case that died a week after the commencement of the disease, the small and large intestines were affected as in the last case, but the rectum was more affected, and looked as if the small blood-vessels were hanging loose in the fibrinous deposit. In a case that died eight days after the commencement of the disease, ulceration was commencing in the cæcum and sloughing in the colon. The description of the typical case may be taken as the next stage of the disease. In a very severe case which had lasted six weeks the whole of the large intestine of a dark colour externally, but not rough, and no effusion on the peritoneum. The interior was a raw, irregular, black surface; the walls were very much thickened, the muscular coat being thickened too, with inflammatory products, and the gut was so friable that almost the least current of water tore it up. In the rectum, blood clots projected from the open mouths of arteries.

Then the healing process was seen in the case of a man who was recovering slowly from the dysentery when he was carried off by pleurisy. In this case the small intestine was normal; but in the cæcum there were small dark-coloured depressed patches, with puckered margins. In the rectum there were healthy granulating ulcerations of a dark colour.

The series of dissections taken along with the symptoms during life enable us to follow the course of the disease as well

as if the inside of the gut had been visible. First, we have inflammation of the mucous membrane of the intestine, commencing in the solitary glands of the ileum, and immediately spreading all over it. In the large intestine it commences all over the surface, not selecting any special element of the membrane. Had it not been for one or two cases, in which the solitary glands of the small intestine were affected first, I should not in any of the other cases have been able to say which element of the membrane was first affected. Then we have the inflammation, immediately followed by a lymph deposit on the membrane. Then we have the ulceration commencing in the small intestines in the solitary glands, not as pustules at first, as some writers affirm always happens in dysentery. In the large intestines the ulceration tends to commence by portions of the membrane sloughing. The capillary vessels all over the inflamed surface from the beginning seem to lose their tone, and many of them to rupture. The contact of the poison as it is being eliminated seems to paralyse them, while it stimulates the nervous ganglia contained in the intestinal walls, causing continuous action of the bowel of a very severe kind. In the cases which recovered we have the fibrinous membrane thrown off in large shreds, as seen in the evacuations, and then we have a granulating healthy sore, which discharges pus till it heals. I cannot account for the tendency to blackening of the surface of the membrane in all the cases.

In some cases the progress of the disease was much more rapid than those I have mentioned. In one case I found the whole of the mucous membrane of the large intestine in a sloughy state after five days' illness. In two cases the small intestines were affected as far up as the junction of the jejunum and the ileum. In two cases there were ecchymosed spots on the mucous membrane of the stomach, and two other cases in which the membrane of the stomach was inflamed and thickened like that of the small intestine. In three cases the small intestine was healthy in appearance, but one of those was the case that was recovering, and died of pleurisy. Another was a case that died of abscess of the liver, after the disease of the bowel had showed signs of improvement, and the third died in a few days from the commencement of the disease. In the first two cases I have no doubt it had passed off, and in the third, contrary to the usual state of things, the larger intestine had become affected first, and the patient being weak, died before the ileum was affected by the disease. The case I have just mentioned, in which there was abscess of the liver, was the only one with this lesion, and it may have been the result either of the dysentery or of the total obstruction of the common bile duct by a large gall-stone which existed.

The pathological appearances I have here recorded are very

rarely to be met with, and I have only been able to discover three recorded outbreaks of dysentery, in which they were at all similar. The one was the epidemic of dysentery that was so fatal to the British troops in the famous Walcheren expedition. Some of the cases recorded by Dr. Davis bear a close resemblance to the cases I have described. In an epidemic of dysentery which occurred at Prague, Dr. Finger records somewhat similar pathological appearances. In two of his 231 cases the jejunum and ileum were affected, and not the large intestine, and these he calls intestinal catarrh. He examined the exudation in his cases by the microscope, and found its structure to be somewhat the same as I have described in my cases. Dr. Mayne found in an epidemic which occurred at Dublin that the most rapidly fatal cases had an exudation on the surface of the mucous membrane, which could be easily scraped off. I had met with three similar cases previously, one in the Edinburgh Infirmary and two in the Royal Edinburgh Asylum.

In no case did I notice the pustular appearance of the glands noticed by so many writers, and I think the record of the pathological appearances and causes of the disease prove that Dr. Baly came to a conclusion from too limited experience when he said that all the forms of dysentery described by systematic writers are merely different stages of the same disease, and that the specific virus which he considered was always the cause of it was always derived from the soil. In its pathological appearances the dysentery I have described bears a much greater resemblance to that form of the disease caused by or connected with malaria than to tropical dysentery. The small intestine is sometimes affected in dysentery that has a malarious origin; but never in dysentery from other causes. But in no epidemic of dysentery of which I have ever read was there a tendency in all the cases to disease of the small intestine. The poison did not cause its effects at once, while it seemed to have no regular period of incubation, like the continued fevers, and unlike most of them it was unaccompanied by a skin eruption. In these respects it resembled malaria. The dysentery resembled ague, too, in having no fixed period of termination; but then it resembled typhoid fever in being accompanied by a specific lesion of the lower part of the intestinal mucous membrane.

The whole of the facts I have stated, and the inferences from these facts, may be thus briefly summed up:—

1. An epidemic of dysentery of a very fatal character occurred in the Cumberland and Westmorland Asylum, in the year 1864-65.

2. All the positive evidence that can usually be produced to determine the cause of any disease can be produced to connect this epidemic of dysentery with exhalations from a field irrigated by sewage, as effect and cause. Ample negative evidence can be

produced to show that no other probable cause of such an epidemic was in operation.

3. The old, weak, paralysed, and diseased patients were chiefly attacked, but it was not confined to them.

4. The majority of the patients attacked were inmates of the wards on the ground floor of the asylum, shewing that the sewage effluvia is most concentrated near the ground. Little or no wind and a high barometrical pressure would seem to be the most favourable conditions for the injurious effects of the poison to manifest themselves.

5. It would seem to be unsafe to apply sewage not deodorized to land with a stiff clay subsoil within 350 yards of human habitations.

6. Diarrhœa in its ordinary form may also be caused by sewage exhalations.

7. There are strong reasons for believing that the sewage effluvia which caused dysentery and diarrhœa in some persons may have caused typhoid fever in others.

8. The sewage poison had a period of incubation in most cases before the dysentery appeared. The length of this period was probably from three to five days.

9. The dysentery was of a very fatal character, and the ipecacuanha treatment, so successful in tropical dysentery, was not so in this epidemic.

10. The two morbid appearances most characteristic of this epidemic were, 1st. a soft membranous deposit on the mucous membrane of the intestines; and 2nd, the diseased conditions of the lower part of the small as well as the large intestines in all the cases.

11. The poison which caused the dysentery seemed to occupy an intermediate position between the poison which causes the continued fevers, and that which produces ague and its concomitants.



